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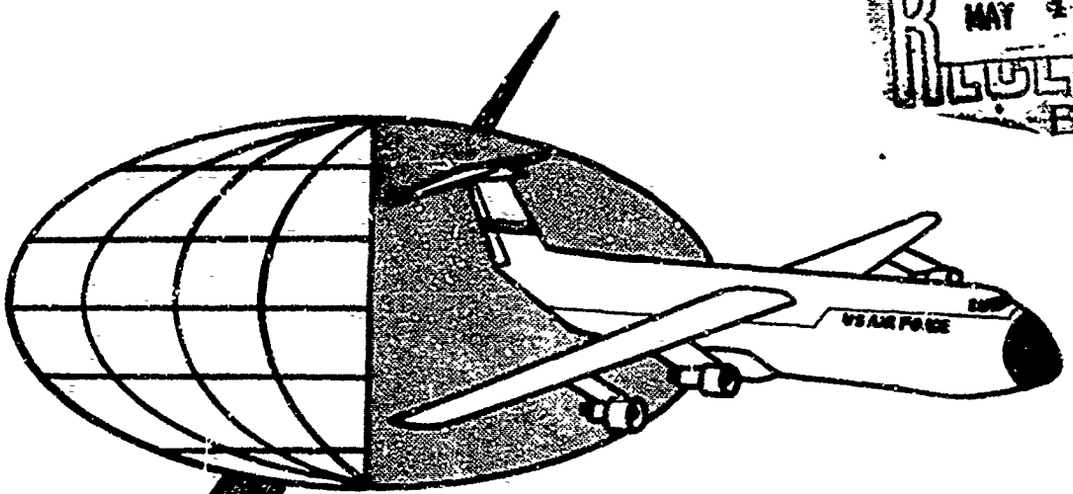

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13. ABSTRACT

A series of tests intended to detect deterioration in physical properties of various MIL-C-6799 strippable coating samples taken from service at the Military Aircraft Storage and Disposition Center (MASDC) were conducted. Although definitive conclusions cannot be drawn from the limited data generated to date, a preliminary determination that the MASDC samples be considered satisfactory was made.

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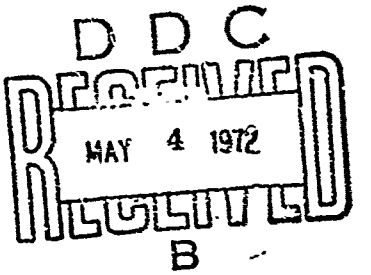

MIL-C-6799 STRIPPABLE COATING EVALUATION

AFLC-WPAFB-FEB 72 40

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ABSTRACT

A series of tests intended to detect deterioration in physical properties of various MIL-C-6799 strippable coating samples taken from service at the Military Aircraft Storage and Disposition Center (MASDC) were conducted. Although definitive conclusions cannot be drawn from the limited data generated to date, a preliminary determination that the MASDC samples be considered satisfactory was made.

Table of Contents

INTRODUCTION:

The basic objective of this project was to determine the extent of preservative coating MIL-C-6799, "Coatings, Sprayable, Strippable, Protective, Water Emulsion", deterioration after extended service at the Military Aircraft Storage and Disposition Center (MASDC), Davis-Monthan AFB, Arizona.

BACKGROUND:

The storage procedures employed at MASDC for the preservation of aircraft are being reviewed in hopes of standardizing Air Force, Navy, and Army requirements and improving the degree of protection offered. Preliminary meetings on a tri-service basis held in January 1972 indicated some concern for the long-term performance of MIL-C-6799 strippable coatings used for sealing aircraft openings and overcoating canopies and surfaces. As a result, the Directorate of Packaging in conjunction with the 4950th Test Wing/LGF was tasked with conducting preliminary studies on coating deterioration.

Description of Test Specimens:

All specimens were MIL-C-6799 coatings and with the exception of sample number 15 were taken from preserved aircraft in storage at MASDC. Specimens were numbered and identified as follows. (All specimens were approximately eight inches square.)

Specimen Number	Identification
1	Coating applied over MIL-B-131 barrier material. Taken from tail pipe of T-33 aircraft, S/N 52-9441. Preservation date 12 Jul 1962.
2	Coating applied over MIL-B-131. Taken from tail pipe of T-33A aircraft, S/N 53-4895, preservation date 4 Jan 1968.
3	Coating applied over canopy of T-33A, S/N 51-9109, preservation date 28 Jul 1966.
4	Coating applied over MIL-B-131. Taken from tail pipe of T-33A, S/N 53-5397, preservation date 13 Jan 1970.
5	Coating applied over canopy of T-33, S/N 52-9441, preservation date 12 Jul 1962.

Specimen Number	Identification
6	Coating applied over canopy of T-33, S/N 52-9240, preservation date 24 Feb 1970.
7	Coating applied over canopy of T-33A, S/N 53-5397, preservation date 13 Jan 1970.
8	Coating applied over MIL-B-131 and taken from tail pipe of T-33, S/N 51-9293, preservation date 25 Jul 1964.
9	Coating applied over aircraft surface of F-111, S/N 63-9776, area 14. Preservation date 29 Oct 1970. Maintenance on 1 Dec 1971.
10	Coating applied over MIL-B-131, taken from tail pipe of T-33A, S/N 51-9109, preservation date 28 Jul 1966.
11	Coating applied over canopy of T-33, S/N 51-9293, preservation date 25 Jul 1964.
12	Coating applied over MIL-B-131. Taken from tail pipe of T-33, S/N 52-9240. Preservation date 24 Feb 1970.
13	Coating applied over canopy of T-33A, S/N 53-4895, preservation date 4 Jan 1968.
14	Coating applied over canopy of T-33A, S/N 53-5098, preservation date 28 Mar 1962.
15	MIL-C-6799 coating (two coats) applied over aluminum panel. Coating applied in Sep 1970 at WRAMA and maintained at these laboratories for over one year at 73°F and 50% RH. Sample No. 15 was used as a control.

Test Equipment:

a. A Honeywell Water Vapor Transmission Rate Tester, Model W825A, was used to measure water vapor transmission rates (WVTR). Determinations were made at 100°F.

b. Tensile strength and elongation determinations were made on a Model TT-C Instron Testing Instrument. Tensile Load Cell D with a maximum full scale range of 1000 pounds was employed.

c. Thickness measurements and visual observations were made with a hand held magnifying viewer and an E. J. Cady dial reading automatic micrometer graduated in 0.001 of an inch.

Test Procedures:

Visual. With the aid of a hand held viewer, each sample was examined for surface defects, cracks, tears, etc. In addition, estimates of the number of coats of material and dry film thicknesses were made.

Environmental Conditions. Prior to the following tests, all specimens were conditioned at 73°F and 50% RH for 48 hours. All tests were conducted at these conditions in an environmentally controlled area. Where it was judged necessary, as between WVTR and tensile/elongation determinations, each specimen was allowed to condition at 73°F and 50% RH between tests. While this period of reconditioning varied from specimen to specimen, the minimum time for any one was 18 hours.

Water Vapor Transmission Rate (WVTR): Test Method T 523 of the Technical Association of the Pulp and Paper Industry was used for determing water vapor transmission rates. Specimens 1, 2, 8, and 10 had the MIL-C-6799 separated from the MIL-B-131 barrier prior to WVTR and tensile/elongation determinations. Although specimens 4 and 12 were also applied over a MIL-B-131 barrier, the coating was too thin to be separated. Therefore, no testing beyond visual examinations was accomplished on these specimens.

Tensile Strength Elongation: The Instron tester was adjusted for elongation and tensile determinations as follows: Cross head speed, 12 inches per minute; chart speed, 12 inches per minute; original gage length, 4 inches. Specimens were cut to a one-inch by six-inch size and five thickness readings of each strip taken and averaged. Specimens were pulled to rupture. The load at break was read from a strip chart elongation; a break was read from instrumentation on the Instron.

Thickness: Thickness measurements of each six by one inch strip used in the tensile-elongaetion determinations were made with a dial micrometer. The five values were averaged for tensile strength calculations.

RESULTS: (Visual Observations)

Specimen No. 1: General condition of the coating was good. Surface had several pits; however, they did not appear to penetrate the topcoat. Surface had three or four small bubbles. Note: Preservation date reported from MASDC is 12 Jul 1962; however, barrier material was produced in March 1968.

Specimen No. 2: Top coat contained no holes, gouges, or cracks; however, there were indications that the base coat was dirty prior to application of top coat. Note: Preservation date is Jan 1968; however, MIL-B-131 was manufactured in Oct 1970.

Specimen No. 3: Top coat was thin; coverage estimated at 80%. Specimen was build-up of four and possibly five coats as follows: Base (black) coat 0.004 inch thick followed by one or two white coats of 0.014 inch thickness, followed by 0.004 inch black coat and 0.004 to 0.014 inch uneven top coat.

Specimen No. 4: Specimen contained only one coat of black material approximately 0.004 inch thick applied to MIL-B-131 barrier. Coating was torn from barrier material and coverage was approximately 90%. MIL-B-131 barrier shows signs of deterioration and delamination.

Specimen No. 5: Top coat cracked and blistered. Black base coat approximately 0.007 inch thick followed by a very uneven 0.014 inch white coat followed by a 0.004 inch black coat while top coat was 0.007 inch thick.

Specimen No. 6: Top coat approximately 90% coverage and 0.004 to 0.014 inch thick base (black) coat approximately 0.014 inch thick.

Specimen No. 7: White top coat of 0.021 inch thickness was uniform and provided excellent coverage to the base (black) coat of 0.004 inch thickness.

Specimen No. 8: Top (white) coat, 0.008 inch thick in good condition with the exception of one small hole. Black base coat was approximately 0.008 inch thick.

Specimen No. 9: White top coat (0.016 inch) in fair condition, contained three or four small bubbles. It appeared that top coat was applied over dirt on black base coat of 0.008 inch.

Specimen No. 10: Scrim backing separated from aluminum foil on MIL-B-131 barrier. Adhesion of coating to barrier appeared adequate. White top coat was approximately 0.016 inch thick and provided uniform coverage. Surface was checked; however, there were no obvious cracks that penetrated the surface. Black base coat was approximately 0.008 inch thick.

Specimen No. 11: White top coat 0.012 inch thick had orange peel but no breaks. Base coat was 0.004 inch thick.

Specimen No. 12: Specimen had only a 0.004 inch black base coat which showed signs of weathering and physical damage.

Specimen No. 13: This specimen had indications of separation of white and black coatings. The white top coat was approximately 0.004 inch thick. Top coat showed approximately 95% coverage. Second coat was black and nearly 0.004 inch thick. Third coat was 0.004 inch white followed by a 0.004 inch thick black base coat.

Specimen No.14: White top coat (0.016 inch) was uniform but marred. Black base coat (0.008 inch) was pot marked on under side which may indicate application over dirty aircraft surface.

Military specification MIL-C-6799 requires that after weathering in the Philadelphia metropolitan area for one year that the coating be strippable in one continuous sheet. All specimens received from MASDC with the exception of number 4 and 12, which were incomplete systems, were easily stripped from either canopy or barrier surfaces.

Water Vapor Transmission Rates: MIL-C-6799 does not specify a minimum water vapor transmission rate. Control specimen No. 15 may be used for comparison purposes. In addition, the WVTR values of MIL-B-131 barrier materials are listed for comparison. MIL-B-131 is a common packaging barrier which is considered to offer excellent water vapor protection. Average WVTR values are given in Table I. Individual determinations are reflected in attachment 1.

Table I. Water Vapor Transmission Rates

Specimen Number	$WVTR_{100^{\circ}F}$ (grams/100 in^2/24 hrs) Exterior to Interior of Sample	Interior to Exterior of Sample
1	0.3	1.3
2	7.6	6.8
3	4.4	0.8
4	N/A	N/A
5	5.6	1.0
6	5.3	1.0
7	2.5	1.3
8	4.5	1.2
9	0.9	1.0
10	2.5	1.0
11	2.4	1.2

Table 1. Water Vapor Transmission Rates (Continued)

Specimen Number	WVTR (grams/100 in^2/24 hrs) 100°F: Exterior to Interior of Sample	Interior to Exterior of Sample
12	N/A	N/A
13	1.9	0.9
14	2.0	3.9
15	1.5	3.8
MIL-B-131 Classes 1 & 2	0.002	N/A

Tensile Strength-Elongation: Average values of tensile strength and elongation are given in Table II. Individual determinations are reflected in attachment 2. MIL-C-6799 requires a minimum tensile strength of 1700 psi and an elongation between 170-350% immediately after application and air drying for 24 hours followed by oven drying at 120°F for 24 hours and 4 hours conditioning at 73°F and 50% RH.

Table II. Tensile Strength/Elongation

Specimen No.	Tensile Strength (psi)	Elongation (% of original length)
1	736	45
2	502	80
3	561	105
4	N/A	N/A
5	810	89
6	668	116
7	619	76
8	1311	64
9	994	129
10	1047	57
11	524	8.6
12	N/A	N/A
13	617	54
14	739	27
15	388	168

Thickness: MIL-C-23760, "Coating, Sprayable, Strippable, Protective, For Preservation and Packaging of Weapon Systems and Components; Application of" recommends a total dry film thickness for MIL-C-6799 coating of approximately 0.012 inch. Average thickness

values are given in Table III;individual values are reflected in attachment 2.

Table III. Thickness

Specimen No.	Thickness (inches)
1	0.017
2	0.008
3	0.030
4	N/A
5	0.039
6	0.024
7	0.019
8	0.021
9	0.018
10	0.021
11	0.027
12	N/A
13	0.027
14	0.032
15	0.027

DISCUSSION:

The physical properity data presented in Table II indicates apparent deterioration of tensile strengths and elongation values specified in the material specification. However, this data is not conclusive for a variety of reasons. MIL-C-6799 requirements are levied on fresh material that has been preconditioned. The specimens from MASDC vary in age from 15 months to 10 years. When the tensile and elongation properties are compared to the 16-month old specimen from WRAMA (identified as Specimen No. 15). A closer correlation exists. It should further be pointed out that the requirements of the specification are determined on essencially "laboratory" samples prepared under near ideal conditions. On the other hand, the WRAMA samples were taken from shops making daily applications in outdoor conditions.

The water vapor transmission rates listed in Table I correlate fairly well with the control specimen with the exception of the higher rate in the interior to exterior direction on the control. The MASDC specimens with two exceptions, Specimens No. 1 & 9, exhibited the reverse--higher transmission rates in the exterior to interior direction--which is, of course, the direction of transmission when coatings are in service. At this time no logical explanation can be offered that would account for such a difference.

CONCLUSIONS/RECOMMENDATIONS:

The MIL-C-6799 coatings examined showed a marked difference in properties from the specification requirements. However, based on the data presented and with full knowledge that the coating used in normal preservation and packaging operations is considered to have a maximum service life of 18 months, the materials received from MASDC are considered in satisfactory condition. Such preliminary conclusions are admittedly based upon a very small sample size and chronological cross section. Before more definitive conclusions can be made, the scope of the testing program must be expanded.

At this time two recommendations are offered: (1) that,as an interim policy, the MIL-C-6799 coating program at MASDC be considered acceptable and continue and (2) that a more comprehensive coating evaluation be conducted in an attempt to determine the rate of coating deterioration at MASDC facilities.

NOTE:

The values reported for water vapor transmission rates (WVTR) in attachment 1 and Table 1 are not as accurate as was originally expected. Difficulties discovered with the test apparatus after completion of these determinations and publication of this report in February 1972 lead us to believe that stabilized conditions were not reached with each specimen before testing was terminated.

In general, the results reported in February are accurate to the first decimal place and are valid in relative values and magnitude. With these factors in mind, the WVTR averages of the specimens would be expected to change as follows.

	Revised WVTR (grams/100 in2/24 hrs)	
Specimen Number	Exterior to Interior	Interior to Exterior
1	N/C - 0.3	N/C - 1.3
2	N/C - 7.6	8.2
3	4.0	N/C - 0.8
5	3.4	N/C - 1.0
6	4.3	N/C - 1.0
7	2.4	N/C - 1.3
8	4.0	N/C - 1.2
9	N/C - 0.9	N/C - 1.0
10	N/C - 2.5	0.9
11	2.2	1.0
13	1.8	N/C - 0.9
14	1.8	N/C - 0.9
15 Sample 1	1.6	3.5
Sample 2	N/C - 1.5	

N/C - Indicates no change in WVTR-stable condition was obtained during test.

Wm R Drake 18 Apr 1972
WILLIAM R. DRAKE, Chemical Engr
Materials Division, Directorate
of Packaging

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WATER VAPOR TRANSMISSION RATES

SPECIMEN NO. 1

Exterior to Interior			Interior to Exterior		
Seconds		g/100 in^2/24 hrs	Seconds		g/100 in^2/24 hrs
598	*	0.2	26		4.4
509	*	0.2	43		2.7
428	*	0.4	64		1.8
391	*	0.3	75	*	1.5
352	*	0.3	90	*	1.3
	Average	0.3	104	*	1.1
			105	*	1.1
				Average	1.3

SPECIMEN NO. 2

Exterior to Interior			Interior to Exterior		
Seconds		g/100 in^2/24 hrs	Seconds		g/100 in^2/24 hrs
15	*	7.7	27	*	4.3
15	*	7.7	20	*	5.7
15	*	7.7	17	*	6.8
16	*	7.2	16	*	7.2
15	*	7.7	15	*	7.7
	Average	7.6	13	*	8.8
				Average	6.8

SPECIMEN NO. 3

Exterior to Interior			Interior to Exterior		
Seconds		g/100 in^2/24 hrs	Seconds		g/100 in^2/24 hrs
17		6.8	34		3.4
22	*	5.2	106		1.1
25	*	4.6	119		1.0
27	*	4.3	132		0.9
28	*	4.1	144	*	0.8
30	*	3.8	145	*	0.8
	Average	4.4	161	*	0.7
			158	*	0.7
				Average	0.8

* Conditions stablized--only these values used in calculating average.

Atch #1

SPECIMEN NO. 5

Exterior to Interior			Interior to Exterior		
Seconds		g/100 in^2/24 hrs	Seconds		g/100 in^2/24 hrs
17	*	6.8	32		3.6
20	*	5.8	44		2.6
22	*	5.2	75		1.5
24	*	4.8	106	*	1.1
27	*	4.3	120	*	1.0
30	*	3.8	129	*	0.9
36		3.2	136	*	0.8
	Average	5.1		Average	1.0

SPECIMEN NO. 6

Exterior to Interior			Interior to Exterior		
Seconds		g/100 in^2/24 hrs	Seconds		g/100 in^2/24 hrs
17	*	6.8	42		2.7
19	*	6.1	57		2.0
21	*	5.5	71		1.6
23	*	5.0	86		1.3
26	*	4.4	97	*	1.2
28	*	4.1	118	*	1.0
	Average	5.3	128	*	0.9
			132	*	0.9
				Average	1.0

SPECIMEN NO. 7

Exterior to Interior			Interior to Exterior		
Seconds		g/100 in^2/24 hrs	Seconds		g/100 in^2/24 hrs
19		6.1	35		3.3
28		4.1	47		2.4
34		3.4	58		2.0
38		3.0	68		1.7
41	*	2.8	76		1.5
44	*	2.6	85	*	1.4
46	*	2.5	90	*	1.3
48	*	2.4	92	*	1.3
48	*	2.4	92	*	1.3
	Average	2.5		Average	1.3

SPECIMEN NO. 8

Exterior to Interior			Interior to Exterior		
Seconds		g/100 in^2/24 hrs	Seconds		g/100 in^2/24 hrs
16		7.2	39	*	2.9
18		6.4	95	*	1.2
22	*	5.2	101	*	1.1
25	*	4.6	108	*	1.1
27	*	4.3	106	*	1.1
30	*	3.8	94	*	1.2
	Average	4.5		Average	1.2

SPECIMEN NO. 9

Exterior to Interior			Interior to Exterior		
Seconds		g/100 in^2/24 hrs	Seconds		g/100 in^2/24 hrs
33		3.5	40		2.9
84		1.4	54		2.1
102		1.1	67		1.7
115	*	1.0	100		1.2
124	*	0.9	110	*	1.0
125	*	0.9	114	*	1.0
124	*	0.9	111	*	1.0
	Average	0.9	114	*	1.0
			110	*	1.0
				Average	1.0

SPECIMEN NO. 10

Exterior to Interior			Interior to Exterior		
Seconds		g/100 in^2/24 hrs	Seconds		g/100 in^2/24 hrs
13		8.8	33		3.5
24		4.8	82		1.4
45	*	2.6	95		1.2
46	*	2.5	107	*	1.1
48	*	2.4	113	*	1.0
	Average	2.5	123	*	0.9
			125	*	0.9
				Average	1.0

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SPECIMEN NO. 11

Exterior to Interior

Seconds		g/100 in^2/24 hrs
15		7.7
18		6.4
23		5.0
28		4.1
38	*	3.0
44	*	2.6
49	*	2.3
52	*	2.2
56	*	2.1
	Average	2.4

Interior to Exterior

Seconds		g/100 in^2/24 hrs
32		3.6
43		2.7
55		2.1
70		1.6
81	*	1.4
90	*	1.3
104	*	1.1
114	*	1.0
	Average	1.2

SPECIMEN NO. 13

Exterior to Interior

Seconds		g/100 in^2/24 hrs
18		6.4
46		2.5
58	*	2.0
61	*	1.9
63	*	1.8
68	*	1.7
	Average	1.9

Interior to Exterior

Seconds		g/100 in^2/24 hrs
31		3.7
45		2.6
79		1.5
118	*	1.0
127	*	0.9
134	*	0.9
	Average	0.9

SPECIMEN NO. 14

Exterior to Interior

Seconds		g/100 in^2/24 hrs
15		7.7
29		4.0
33		3.5
36		3.2
38		3.0
53	*	2.2
57	*	2.0
59	*	1.8
66	*	1.7
	Average	2.0

Interior to Exterior

Seconds		g/100 in^2/24 hrs
24		4.4
34		3.4
51		2.3
61		1.9
82		1.4
102	*	1.1
127	*	0.9
137	*	0.8
	Average	0.9

SPECIMEN NO. 15 (Sample 1)

Exterior to Interior			Interior to Exterior		
Seconds		g/100 in^2/24 hrs	Seconds		g/100 in^2/24 hrs
45		2.6	14		8.2
88	*	1.3	24	*	4.8
104	*	1.1	28	*	4.1
90	*	1.3	32	*	3.6
76	*	1.5	35	*	3.3
69	*	1.7	37	*	3.1
	Average	1.4		Average	3.8

SPECIMEN NO. 15 (Sample 2)

Exterior to Interior			Interior to Exterior	
Seconds		g/100 in^2/24 hrs	Seconds	g/100 in^2/24 hrs
43		2.7		
73	*	1.6		
90	*	1.3		
83	*	1.4		N/A
76	*	1.5		
	Average	1.5		

TENSILE THICKNESS ELONGATION

SPECIMEN NO. -	THICKNESS (inch)	TENSILE STRENGTH (psi)	ELONGATION (% Original Length)
1 Strip a	0.021	667	54
b	0.019	632	69
c	0.018	667	73
d	0.015	867	41
e	0.015	1047	17
f	0.012	533	23
Average	0.017	736	45
2 Strip a	0.009	472	187
b	0.007	671	188
c	0.008	450	164
d	0.008	473	181
Average	0.008	502	180
3 Strip a	0.033	552	79
b	0.035	703	127
c	0.027	593	90
d	0.029	517	131
e	0.027	519	121
f	0.028	446	93
g	0.028	507	112
h	0.030	653	83
Average	0.030	561	105
5 Strip a	0.039	838	103
b	0.038	789	91
c	0.038	816	93
d	0.037	905	78
e	0.040	838	57
f	0.038	884	61
g	0.038	737	139
h	0.040	675	93
Average	0.039	810	89
6 Strip a	0.028	579	150
b	0.023	635	124
c	0.029	783	153
d	0.022	682	104
e	0.020	600	52
f	0.022	727	115
Average	0.024	668	116

Atch #2

SPECIMEN NO.	THICKNESS (inch)	TENSILE STRENGTH (psi)	ELONGATION (% Original Length)
7 Strip a	0.023	750	117
b	0.018	569	61
c	0.017	694	82
d	0.017	588	73
e	0.019	592	64
f	0.019	526	66
g	0.020	562	85
h	0.018	667	83
Average	0.019	619	76
8 Strip a	0.010	1740	26
b	0.023	1157	70
c	0.022	1295	70
d	0.024	1250	59
e	0.027	1111	94
Average	0.021	1311	64
9 Strip a	0.018	1059	139
b	0.017	1083	126
c	0.019	947	153
d	0.017	909	123
e	0.017	971	129
f	0.017	971	120
g	0.017	1024	125
h	0.018	1006	117
Average	0.018	994	129
10 Strip a	0.019	1342	69
b	0.019	1053	56
c	0.026	904	42
d	0.021	886	66
e	0.021	1048	50
Average	0.021	1047	57
11 Strip a	0.029	465	4
b	0.025	536	5
c	0.026	538	18
d	0.027	555	7.5
Average	0.027	524	8.6

SPECIMEN NO.	THICKNESS (inch)	TENSILE STRENGTH (psi)	ELONGATION (% Original Length)
13 Strip a	0.023	639	36
b	0.024	612	67
c	0.038	479	66
d	0.025	620	46
e	0.023	665	56
f	0.027	689	50
Average	0.027	617	54
14 Strip a	0.031	887	14
b	0.032	508	25
c	0.033	712	41
d	0.030	793	25
e	0.033	736	39
f	0.030	800	20
Average	0.032	739	27
15 Strip a	0.027	444	198
b	0.026	435	164
c	0.028	286	148
d	0.024	375	148
e	0.027	333	160
f	0.028	454	192
Average	0.027	388	168

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